Fig. 3 is a plan view of a six-pole rotor design of another aspect of the present invention;

Please add the following new paragraph [0024.1] after paragraph [0024]:

Figs. 4A-4C are three examples of possible shapes for the depressed portions of the rotor yoke of the rotor design of Fig. 3;

A1 cont

Please replace paragraph [0025] with the following paragraph:

Fig. 5 is a graph of rotor angle versus magnetic flux density of a motor incorporating the rotor designs according to Figs. 1 and 3; and

Please add the following new paragraph [0025.1] after paragraph [0025]:

Fig. 6 is a partial cut-away side view of the rotor yoke according to one aspect of the present invention.

Please replace paragraph [0026] with the following paragraph:

A2

The present invention is intended to reduce cogging torque in permanent magnet motors by improving the alignment of magnet poles as is shown in the drawing, particularly in Figs. 1-4 and 6. Figure 1 shows a four-pole rotor design according to one aspect of the invention. Specifically, Fig. 1 shows a rotor 10 surrounded by a stator core 12 without windings. The stator core 12 is preferably a stack of ferrous stator laminations. Here, the stator core 12 is a twelve-tooth design by example only. The rotor 10 is mounted on a rotatable shaft 14. The yoke 16 of the rotor 10 according to this aspect of the invention is an annular steel yoke 16 extending a predetermined radius R_1 from the center of the shaft 14. Alternatively, the yoke 16 comprises a stack of ferrous laminations 54 as shown in Fig. 6. Coupled to the yoke 16 is a ring magnet 18 with a peripheral edge 20 at a maximum radius R_2 from the center of the shaft 14.

Please replace paragraph [0029] with the following paragraph:

The depth and width of the shape is derived from an iterative process starting when a rotor 10, including the number of poles and the shape and size of the depressed portions 26, is chosen. Then, numerical modeling of the rotor 10 and stator, such as a stator incorporating the stator core 12, is performed to calculate cogging torque, output torque, magnetic field strength and other machine variables for the particular electric machine design. The depth or the width of the depressed portions 26 is adjusted, and the numerical modeling is performed again until the machine design is optimized. The shape may also be changed. The machine design is optimized when the magnetic field generated by the magnets is roughly sinusoidal as shown in Fig. 5, and other machine variables are optimized. For example, an optimized design maximizes output torque and minimizes cogging torque. Of course, the machine must be designed to operate in the linear range of its flux density curve. Other variables of the machine design known to those skilled in the art are also modeled and can be included in the optimization.

A3

Please replace paragraphs [0032] - [0036] with the following paragraphs:

Figure 3 shows a rotor design according to another aspect of the invention. The rotor 100 is mounted on a rotatable shaft 14 and includes a yoke 30 surrounded by an annular ring magnet 32. As previously discussed, the ring magnet 32 is formed of a magnetic material, either a rare-earth magnetic material or a ceramic magnetic material and can be formed by extrusion or by pressing. The ring magnet 32 of Fig. 3 has six poles, each generally centered at line 34. The poles of the ring magnet 32 can be formed by subjecting the ring magnet 32 to either radial or parallel magnetization.

A4

The yoke 30 of the rotor 100 comprises a stack of ferrous laminations extending to a maximum predetermined radius R4 from the center of the shaft 14 to a peripheral edge 36. The yoke 30 can include skew. In another aspect, the yoke 30 is a solid steel yoke. The yoke 30 is roughly annular in shape but has a plurality of depressed portions, or depressions, 38 along the peripheral edge 36. Each depressed portion 38 is located and preferably centered about a junction 40 at the midpoint between two poles, each of which is centered at a line 34. The depressed portion 38 of the peripheral edge 36 in the embodiment of Fig. 3 extends from radius R_4 to a minimum radius R_5 along a radial path, follows a circumferential path along the same radius R_5,

then extends along another radial path to the peripheral edge 36 at radius R_4 to form a shallow, roughly trapezoidal shape.

The shape of the depressed portion 38 of the peripheral edge 36 of the rotor yoke 30 is shown as a roughly trapezoidal shape by example only. Each depressed portion 38 can form any shape located around the junction 40. Preferably, each depressed portion 38 is the same shape, and each is symmetrical about the junction 40, but this uniformity is not necessary. Figures 4A through 4C show three examples of other shapes the depressed portion 38 can take. The depressed portion 38 of Fig. 4A forms an arc roughly ovoid in shape, i.e., the depressed portion 38 starts at the outside peripheral edge 36 and approaches the edge of the rotatable shaft 14 in a continuously curved segment and returns to the outside peripheral edge 36. In the aspect shown in Fig. 4B, the depressed portion 38 forms the apex of a shallow triangle in the peripheral edge 36 by two edge segments each starting at the outside peripheral edge 36 and joining at a point 48 closer to the rotatable shaft 14. Finally, Fig. 4C shows the depressed portion 38 as a scallop-shape depression in the peripheral edge 36. The scalloped-shaped depression 38 is formed of two of more concave arcs 50 (only two shown) starting at the peripheral edge 36 and extending into the ring magnet 18. Each set of concave arcs 50 join at a smaller convex arc 52. The depressed portion 38 can also take the shallow, concave groove shape of the depressed portion 26 of the ring magnet 18 shown in Fig. 1.

A4 cont

The depth and width of the shape, as was previously described, is derived from an iterative process starting when a rotor 100, including the number of poles and the shape and size of the depressed portions 38 are chosen. Then, numerical modeling is performed to optimize the particular machine design by changing the size, i.e., the depth or width, of the shape. In some circumstances, the shape itself must be changed during the iterative process. The depth or the width of the depressed portions 38 is adjusted, and the numerical modeling is performed again until the machine design is optimized. Consistent with the previous discussion, it is desired in the design that the magnetic field generated by the magnets is roughly sinusoidal as shown in Fig. 5, and other machine variables are optimized.

As mentioned, the yoke 30 of the rotor 100 preferably comprises a stack of ferrous laminations. The laminations are formed of thin, metal sheets pressed, or stamped, then joined